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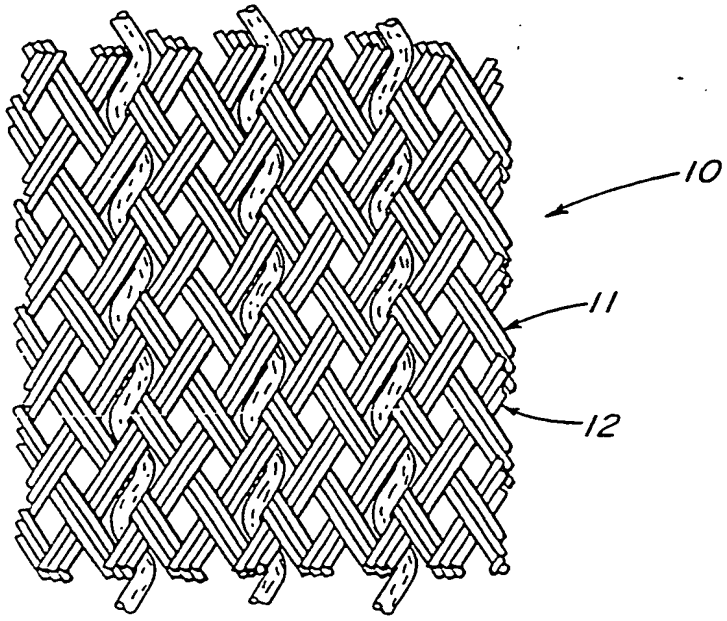

(57) Abstract

Sleeves (10) of braided monofilament formed from resilient materials are fabricated incorporating flexible, non-resilient (i.e. relatively limp) multifilament warp yarns. Monofilaments braided from strands (11, 12) of high modulus engineered plastic materials provide enhanced pushbak and springback properties in sleeves formed of the braided material and the incorporation of relatively limp warp yarns such as spun or texturised yarns impart body, coverage and improved tensile strength without sacrifice of springback properties. "Loopies" which are characteristic of the use of monofilament warp yarns are avoided.

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ABRASION RESISTANT BRAIDED SLEEVE

Field of the Invention

This invention relates to braided products in general and in particular to braided tubular sleeving which can be placed over various substrates such as wire bundles, pipes, conduits, electrical cables, air hoses and the like to provide abrasion resistance and improved appearance.

Background of the Invention

Some substrates such as electrical wire or cable are overbraided with wire to provide electrical shielding and other substrates such as hydraulic hoses are overbraided with wire or other materials to provide increased strength characteristics. In both instances the overbraiding can also provide increased abrasion resistance and durability for the product. However, in many instances it is

impractical to overbraid such substrates with a desired exterior material. For example, electrical wires and cables are frequently installed in computer installations and particularly in robotic installations wherein it is desirable to bundle a number of wires or cables together and retrofit a flexible sleeving over the wire or cable bundle at the time of installation or some time after the original installation. In other circumstances it is desirable to protect other conduits such as air, water or other hoses by retrofitting sleeving over the hose at the time or installation or thereafter.

Braided tubular sleeving has conventionally been used as field installed protective sleeving. One such product is the EXPANDO self-fitting protective oversleeve made by Bentley-Harris Manufacturing Co., Lionville, Pennsylvania. The EXPANDO sleeving is a braided tubular product made from a resilient engineering plastic yarn such a monofilament polyester. The EXPANDO oversleeve is particularly well suited for field installation over wire and cable bundles or harnesses, hoses, and the like because the sleeving material has an open weave construction which enables the braided tube to expand three times its original diameter when the braided tube is axially compressed. When the axial compression is released the braided tube tends to return to its original smaller diameter due to the resilient nature of the engineering

plastic yarn from which it is braided. This "springback" property gives the braided sleeving the desirable characteristic of being self-fitting and conforming to any size substrate which is larger than the original diameter of the sleeve and to any irregular shape of wire and cable bundle. Once installed on the substrate the braided sleeving tends to remain tightly conformed to the exterior of the substrate. Since the braided open weave construction of the oversleeving is very flexible, the oversleeving easily conforms during any bending and flexing of the substrate thus providing continual protection for the substrate.

Summary of the Invention

This invention provides a braided tubular abrasion resistant sleeve comprising a resilient monofilament strand combined with nonresilient, limp multifilament warp yarn, the warp yarn preferably being of larger diameter in relation to the monofilament. Preferably the resilient yarn comprises an engineering plastic having a tensile modulus of at least 100,000 psi and the warp yarns are spun or texturised yarns.

The preferred resilient yarn comprises polyester and the preferred warp yarn comprises any limp, nonresilient natural or synthetic multifilament yarn and may be a

texturised or spun yarn. Within these broad parameters, the particular warp yarn chosen will be dependent upon the desired end purpose.

An important objective of the invention is the provision of abrasion resistant braided sleeves which have improved coverage and tensile strength properties without sacrifice of the desirable springback of such sleeves.

A still further object of the invention is the use of warp yarns in a braided resilient sleeve for longitudinal stiffness, coverage and dimensional stability, without impairment of the pushback and springback capability of the braided tubular structure.

A still further object of the invention is the provision of warp yarns in a braided sleeve in which the warp yarns are constructed so as to eliminate the tendency to loop and snag as the braided structure is expanded and then contracted.

General Description of the Drawings

Figure 1 shows a braided sleeve according to the present invention; and

Figure 2 shows a fragmentary view on an enlarged scale, schematically illustrating the construction of the sleeve of Figure 1.

Description of the Invention

Although flat braiding techniques may be employed, the braided products formed by the teachings of this invention may be fabricated using conventional circular braiding equipment. As is recognized in the art, a circular braider is provided with a ring of studs distributed in uniformly spaced relationship around the braider with each stud receiving a spool of strand or yarn. Movement of the spools in sinuous paths produces a braided sleeve of selected properties in a manner known to those of ordinary skill in the art.

In carrying out the invention, spools of engineered plastic monofilament strand each comprised of 1 to about 10 monofilaments are uniformly distributed on the ring of studs. Additional studs between the studs for supporting the spools of monofilament strand are provided for the support of spools for the warp yarns utilized in the present invention. In accordance with the conventional techniques, known to those of ordinary skill in the art, the braider is used to form an open weave braid which is highly flexible and radially expandable to facilitate

installation over wire bundles or hoses which may have irregularly shaped connectors or fittings attached. The facility of radially expanding and contracting allows the sleeving to snugly and neatly conform to irregularities in the profile of the cable bundle or hose.

The resilient engineered plastic strand useful in this invention should have sufficient tensile modulus to provide the desired springback characteristic in the braided sleeving. Preferably, the strand used is polyester but it will be appreciated that any of the family of plastics known as engineered plastics are suitable for use in the sleeves of this invention. By resilient engineered plastics, it is meant that the plastic has a tensile modulus of greater than 100,000 psi and preferably greater than 150,000 psi and more preferably at least 200,000 psi. Examples of engineered plastics are the olefin polymers, of which some preferred olefin polymers are high density polyethylene, polypropylene, polybutene-1, poly 4-methyl pentene and fluorinated polyolefins such as ethylenetrifluorochloroethylene copolyers, ethylene-tetrafluoroethylene copolymers, and vinylidene fluoride polymers, especially polyvinylidene fluoride, and blends thereof, for example, the fluorinated olefin blends as described in British patent No. 1,120,131; polyesters, for example, polyethylene terephthalate, polytetramethylene terephthalate for example those treated as described in

U.S. patent Nos. 3,968,015; 4,073,830 and 4,113,594; polyphenylene-oxide and -sulphide, blends of polyethylene oxide with polystyrene, silicone-carbonate block copolymers, polyketones, such as polyarylether ketones, for example, those described in U.S. patent Nos. 3,953,400; 4,024,314; 4,229,564; 3,751,398; 3,914,298; 3,965,146; and 4,111,908; polysulphones, for example, polyaryl sulphones, polyarylether sulphones, polyetherimides, for example those described in U.S. patent No. 3,847,867, polycarbonates especially those derived from bis phenol-A, polyamides, especially those described in U.S. patent No. 3,551,200 and 3,677,921, epoxy resins and blends of one or more the above-mentioned polymeric materials either with each other or with other polymeric materials. Additional discussion of such materials is found in British specification No. 1,529,351. The disclosure of the above patents and specifications are incorporated herein by reference.

Although other monofilament yarns or strands may be employed, in forming a one inch internal diameter sleeve, polyester monofilament strands having a diameter of about 10 mils such as are available under the trade mark ESTRALYN from Johnson Filament of Williston, Vermont are provided in strand form wherein each strand is comprised of three monofilament ends. The strands are loaded on

each of 48 carriers on the braider and are braided to form a sleeve of open weave construction.

A braided sleeve so formed has excellent pushback and springback characteristics so that it readily and easily is made to fit over elongated substrates and is easily radially expanded and contracted so as to snugly fit over regular surfaces.

In carrying out the objectives of the present invention a sleeve of the type described is modified by the addition of relatively limp multifilament warp yarns. These warp yarns are preferably spun or texturised yarns. Other yarns may be employed provided that they meet the requirement of being relatively limp. Such yarns may be formed from either natural or synthetic fibres, the synthetic fibres being either organic or inorganic fibres. For applications where it is desirable to increase the density and reduce the permeability of the braided structure, bulkier warp yarns may be employed. For applications where the warp yarns are to be provided to increase the tensile strength of the product, as for example wiring harnesses, where the sleeve provides strain relief, less bulky yarns, characterized by their tensile properties will be employed. Likewise the number of warp yarns in relation to the monofilament strands will be dependent upon the end use of the particular product. In conventional braiding

equipment, an extra stud is provided between each braider bobbin stud and this stud may be utilized for a spool of warp yarn. Thus, bobbins of warp yarn may be provided between every other braid strand bobbin for a product having maximum coverage and good pushback and springback. Where stability or strain relief are the primary requirements, the ratio of warp yarns to monofilaments may vary substantially depending upon the desired properties and the tensile strangth of the warp yarns, For example, an end product of open braid construction, where it is desirable to increase the structural stability of the product and provide strain relief while retaining the open construction to allow for air flow, may have warp yarns present in a ratio of 1 to about 2 to 4 braided monofilament strands. This can be accomplished by placing the spools of warp yarns between the appropriate groups of spools of braid strands. A sleeve 10 formed in accordance with the invention is shown in Figures 1 and 2. The sleeve comprises strands 11 and 12, each comprised of 3 monofilament ends. Warp yarns 13 extend lengthwise of the sleeve.

In use of a sleeve formed in accordance with the invention, when the sleeve is pushed back and radially expanded, the relatively limp warp yarns compress and tend to uniformly form very small loops between each of the cross over points in the braided structure. When the

braided structure is allowed to springback, the warp yarns return to their original straightened condition within the structure so that none of these loops remain. In contrast, when warp yarns or strands of monofilament are utilized to give the structure body, these warp monofilaments slip relatively to the braided strands and tend to buckle at irregular intervals producing relatively large loops or kinks at the points where buckling takes place. When the braided structure springs back to its original configuration, these loops, commonly called "loopies" by those working in this art, remain. These loopies not only detract from the appearance of the sleeve, they greatly impair the function since they are easily snagged and broken and are targets for abrasion. Ultimately, they lead to kinks and holes in the harness, destroying its usefulness. In contrast, the multifilament yarns add strain relief, coverage and stability to the braided product without the disadvantage caused by the monofilament loopies.

If desired, the multifilament warp yarns of the invention may be comprised of filaments coated with a heat activatable adhesive. Sleeves so formed would have the properties of a braided sleeve during installation. Once in place, particularly in applications where abrasion from vibration or movement is a problem, the adhesive is activated to permanently lock the structure in place.

As indicated above, the warp yarns may be added in a similar fashion to flat braided monofilament sheets. The multifilament warp yarns substantially eliminate the fishnet characteristic of tapes or sheets made entirely of monofilament yarns and eliminate the tendency to form "loopies" as well as the stiffness imparted to such a braided structure when monofilament warp yarns are included.

Example

A one inch internal diameter sleeve was braided using a 96 carrier circular braider from strand comprised of three ends of 10 mil monofilament polyester available under the trade mark ESTRALYN sold by Johnson Filament of Williston, Vermont. This material has a modulus of elasticity of 750,000 psi. Between every 7 carriers there was provided a carrier of texturised warp yarn of 1,000 denier multifilament nylon available under the trade mark CORDURA sold by E.I. DuPont De Nemours. This warp yarn is a relatively limp yarn imparted to the braided sleeve improved body and coverage, without impairment of its springback characteristics.

CLAIMS

1. A tubular sleeve comprising braided, resilient strand, characterised in that said resilient strand comprises from 1 to about 10 monofilament ends of an engineering plastic material having a modulus of elasticity of at least 500,000 psi, together with uniformly distributed, flexible and nonresilient relatively limp warp yarns interthreaded into said braid.

2. A sleeve according to claim 1, characterised by the provision of about one relatively limp warp yarn for every 1-4 strands of monofilament.

3. A sleeve according to claim 1, further characterised by the provision of about one relatively limp warp yarn for every 2 strands of resilient strand.

4. A sleeve according to any of claims 1-3, wherein the monofilaments are a polyester.

5. A sleeve according to any preceding claim wherein the monofilaments have a diameter of about 6 mils to about 15 mils.

6. A braided structure for use in forming tubular sleeves or the like, said braided structure being characterised in that it comprises a resilient strand comprised of at least one monofilament end having a modulus of elasticity of at least 100,000 psi and a relatively limp multifilament warp yarn interlaced at predetermined intervals into said braided structure.

7. A braided structure according to claim 6 characterised in that said resilient strand comprises from about 2 to about 6 ends of polyester monofilament having a diameter of about 6 to about 5 mils and a modulus of elasticity of about 750,000 psi.

FIG. 1

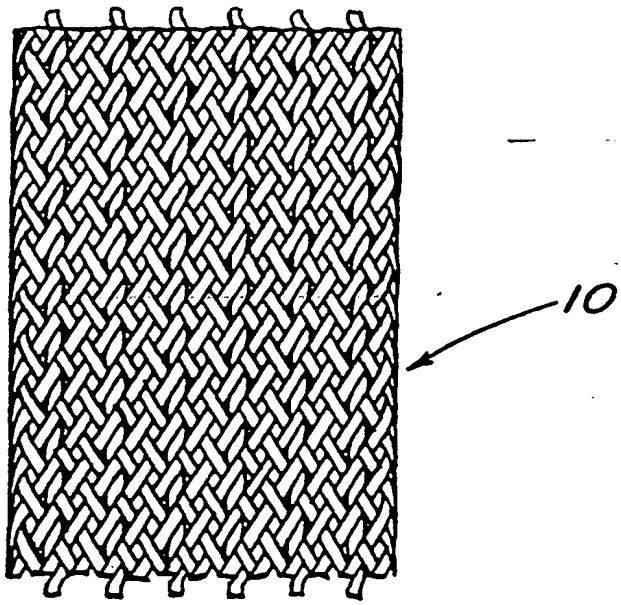
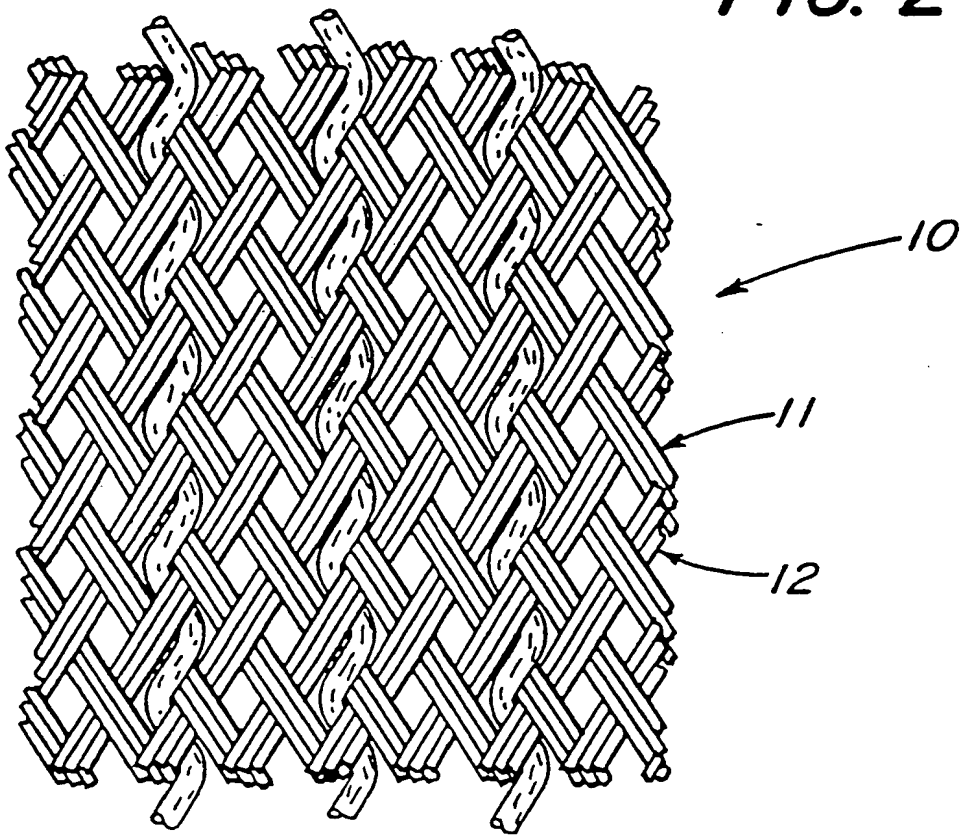


FIG. 2



INTERNATIONAL SEARCH REPORT

PCT/GB 90/01498

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 D04C1/06

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	D04C ; F16L ; H01B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	DE,A,3 344 866 (MICAFIL AG) March 14, 1985 see page 7, line 1 - page 8, line 3; figures 1-3 ---	1,2
A	EP,A,0 249 333 (RAYCHEM CORPORATION) December 16, 1987 see page 12, line 1 - line 8; figures 1,2 ---	1,4,5
A	EP,A,0 134 864 (PLUMMER) March 27, 1985 ---	
A	EP,A,0 117 057 (RAYCHEM CORPORATION) August 29, 1984 ---	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
11 JUNE 1991	12. 07. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	VAN GELDER

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/GB 90/011

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 11/06/91
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